PROCESS IMPROVEMENT FOR MECHATRONIC AND EMBEDDED SYSTEMS – APPROACH FOR AN ACADEMIC RESEARCH PLATFORM

Uwe Lauschner, Burkhard Igel, Carsten Wolff

uwe.lauschner@fh-dortmund.de, igel@fh-dortmund.de, carsten.wolff@fh-dortmund.de
Research Focus Group pimes
University of Applied Sciences and Arts
FH Dortmund, Germany
Sonnenstraße 96
44139 Dortmund

Keywords: collaborative work, ideapipeline, trendradar, Balanced Scorecard, confluence, Cyber Physical Systems, CPS-Design, cyberinfrastructure

Abstract:

This paper deals with the organization of the research platform "pimes – Process Improvement for Mechatronic and Embedded Systems". This new research platform aims to establish a new school of Cyber Physical Systems (CPS)-Design, which develops processes, methods and tools for the development of intelligent technical systems. It transfers the result into the application domains. pimes labs are virtually connected to a cyberinfrastructure using professional collaborative tools (so-called "corporate wikis" like Confluence/ JIRA).
For the innovation process "Idea to Project" pimes uses some tools to structure the process from the first project idea to a research project. The development of new research areas for pimes is driven by a trendradar, and project ideas are tracked by an ideapipeline. The pipeline has decision stages in which project ideas are forwarded or discarded. A Balanced Scorecard is used for innovation process controlling as well as strategy tool for the further development of the research platform. The research platform itself severs as a case study/ example for the pimes research on innovation management.

1. Introduction

The research platform "pimes – Process Improvement for Mechatronic and Embedded Systems" was founded in summer 2011 by 7 researchers from 2 departments (information- and electrical engineering, computer science) at Dortmund University of Applied Sciences and Arts. This work deals with the innovation process in this research platform as "meta research" on "process improvement" in academic research processes.

2. Field of innovation and School of Cyber Physical Systems (CPS)-Design

Intelligent technical systems are a response to the complexity and dynamism occurring in application domains. Technical systems have to respond to the environment, to adapt and

interact [1], [2]. They have to become more intelligent to meet the existing challenges (e.g. in the fields of sustainability, safety or appropriateness to humans). To improve the intelligence of technical systems is a key task for the developers of tomorrow's products.

The research field of the newly developed research project "pimes - Process Improvement for Mechatronic and Embedded Systems" are processes, methods and tools for the development of intelligent technical systems, primarily in the form of mechatronic and embedded systems. In terms of applied research these processes, tools and methods will be adapted for industrial use in the relevant application domains, optimized and finally developed for practical use. Due to the aspect of process improvement, there is a connecting link between research innovations in the field of developing technical systems and the appliance in companies. The research focus could be seen as a 'house of competencies/technical skills' where scientific results can be adapted, optimized of transferred into the application (see Figure 1).

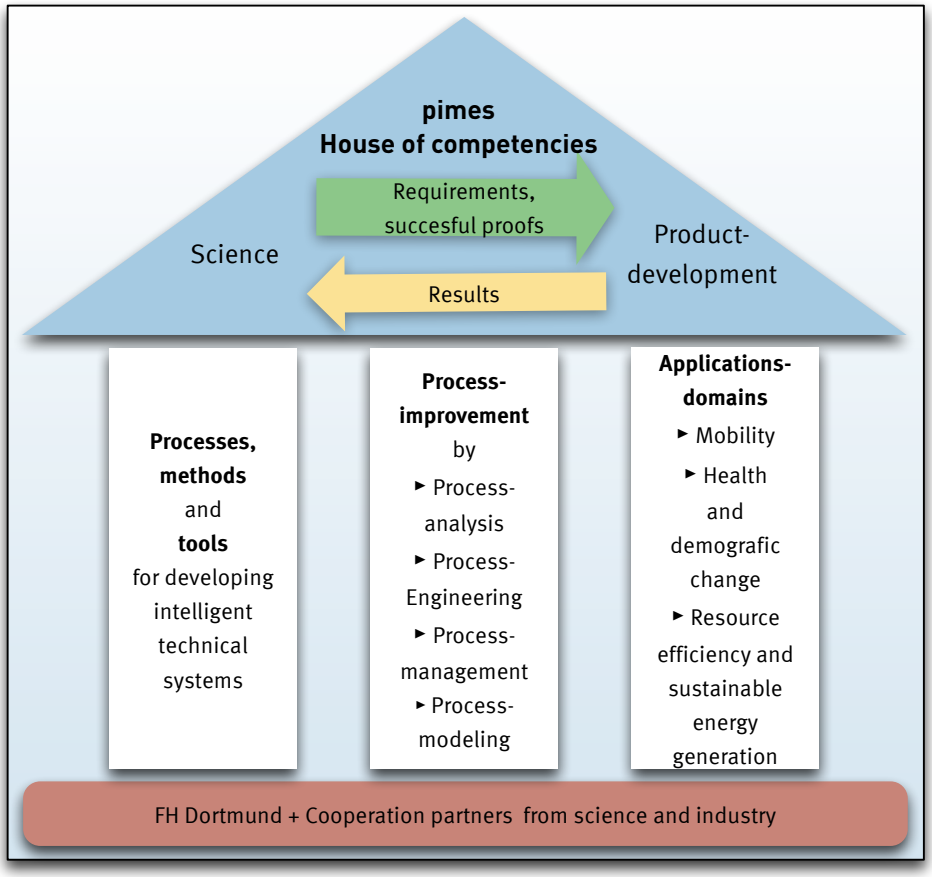

Figure 1: House of competencies

The mission statement of the research focus pimes consists of three points:

- pimes should be established as a 'house of competencies' for the development of intelligent technical systems.
- Especially as a research priority of a University of Applied Sciences and Arts, pimes wants to appear as a national and international known school for CPS (Cyber Physical Systems)-Designs (in terms of a future-oriented method of operation).
- pimes should be understood as an incubator for business models and service offerings in the field of intelligent technical systems.

As described, the pimes researchers aim to establish a new school of CPS-Design. This school develops processes, methods and tools for the development of intelligent technical systems and transfers the result into the application domains. A major goal for research platforms at a University of Applied Science is the education within the meaning of this new school, especially one's own bachelor students, master students and doctoral students. Cyber Physical Systems [3], [4] stand for the current research on highly distributed, networked embedded technical systems that have a strong interaction with their physical environment.
The study courses at the computer science and electrical engineering departments of Dortmund University of Applied Sciences and Arts offer the opportunity to provide this kind of education. The pimes researchers contribute through joint educational events.

3. Cyberinfrastructure for CPS-Design

A goal at pimes is to integrate the school of CPS-Design such as a multimedia networked information, development and transfer platform. For this purpose labs are connected with and the development tools are made available in a virtual infrastructure. The pimes infrastructure is shown in picture 2. It is based in two laboratories at two locations of the University of Applied Science and Arts in Dortmund, which are already in use (Sonnenstraße and Emil-Figge-Str.). In addition, professional collaboration tools (so-called "corporate wikis" like Confluence/ JIRA) are established and made available to external partners. In the current research, such concepts are described as "Cyberinfrastructure" [5]. This Cyberinfrastructure also serves as a demonstrator for own tools, processes and methods. Furthermore, demonstrators and reference environments (Ambient Assisted Living (AAL), collaborative engineering, robotic) are set up in the laboratories to support working progresses and to present the results. The demonstrators are partially created in externally funded projects. The innovation management solutions are developed in cooperation with the EuroMPM (European Master in Project Management)-program.

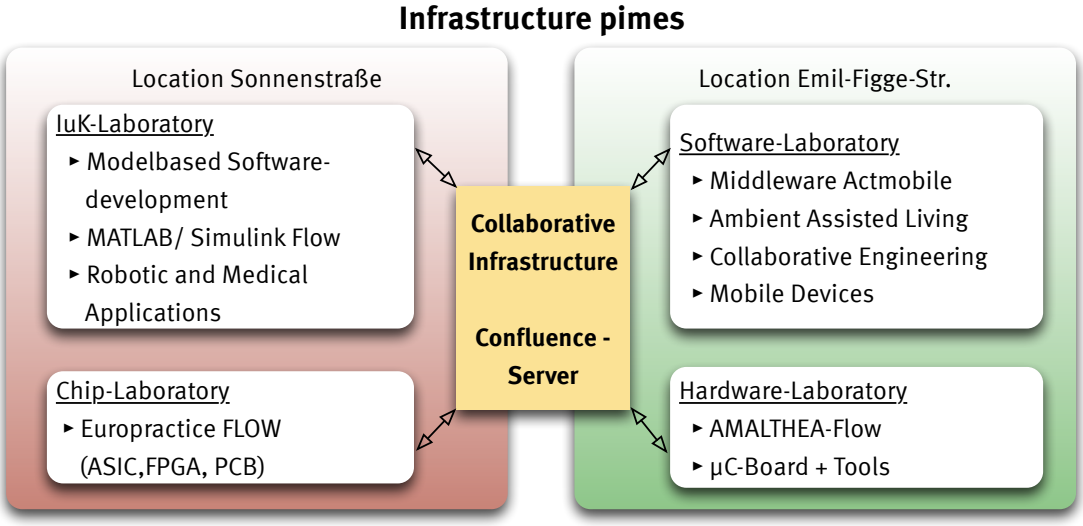

Figure 2: Infrastructure

4. Innovation process “Idea to Project”

Figure 3: Idea to Project

pimes uses structured processes to organize and control the research platform. These structures must be suitable to ensure the efficiency and effectiveness of working processes on the one hand and to promote the creativity of the involved researchers on the other hand. A key example is the “Idea to Project” innovation process shown in figure 3. The phases are connected with tools to assure as much efficiency and sustainability as possible in the pursuit of transforming an idea into a research project.

The development of new research areas for pimes is driven by a trendradar. The fields shown are published by the German federal ministry of education and research [6]. In regular workshops trends (e.g. in the field of mobility) are examined with respect to their relevance for pimes and their maturity for a research project. Interesting ideas reach the center of the radar over several decision stages (gates) and trigger a new project idea. An example for a trendradar is shown in figure 4. Trend C has reached the center of the radar and thus initiates a project idea.

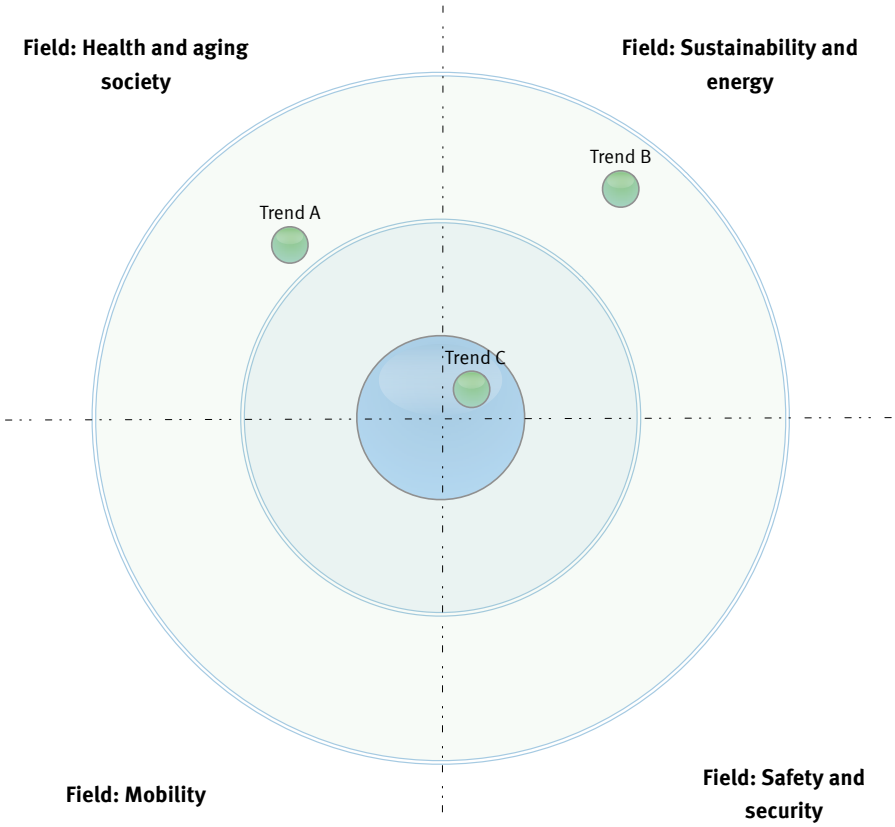

Figure 4: Trendradar

In the project planning phase pimes uses an idea-pipeline (see figure 5). The ideapipeline is a project tracking tool – the project is tracked from the initial idea to the (externally funded) project. The pipeline has several decision stages (gates) in which project ideas are forwarded or discarded. The ideapipeline provides pimes with a quick overview of upcoming and potential projects and their status.

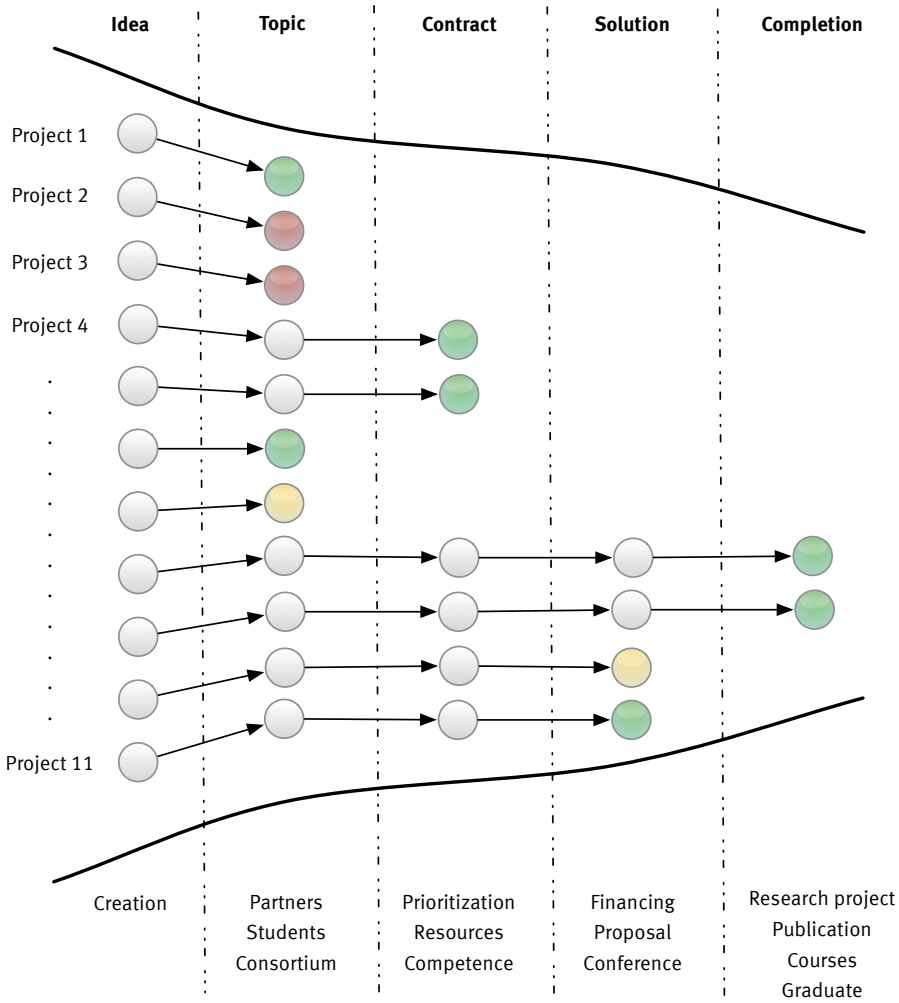

Figure 5: Ideapipeline

The project execution is controlled by a structured project development process and milestones.

A project office supports this process. On going communication between the researchers is carried out in workshops or virtually with the help of the Confluence-Tool. A Balanced Scorecard is used in order to control the innovation process as well as a strategy tool for the further development of the research platform.

The Balanced Scorecard (BSC) was introduced by Norton and Kaplan [7] for the measurement, control and documentation of organizations. The BSC is very successful in the field of industry, pimes now tries to use it in the field of education, where it is used to develop and implement visions and objectives for the research platform. pimes documents different visions and objectives as well as measures for each vision. For example, pimes defines the vision to enlarge its popularity with the industry. To achieve this, an objective like the number of externally funded projects is defined and documented in the BSC. After a year, the number of externally

funded projects is measured. If an objective was not achieved, the potential reasons are tried to be identified and a new objective including new measures is definded. Visions, objectives and measures are linked to each other and provide a strategy for the research platform. From this strategy, a strategy-map is created for pimes.

5. Conclusion and Outlook

The research platform itself serves as a case study/ example for the pimes research on innovation management. The tools presented are tested and partially developed by pimes. There is ongoing research on further possibilities how to organize the research platform. All tools have to be as simple and understandable as possible. If possible the whole organization process should be automated. Every pimes researcher must have the possibility to keep up to date with little effort. With the use of simple but productive tools it is possible to participate in projects without a long training period.

6. References

[1] Dawson, D. ; Seward, D. ; Bradley, D.A. ; Burge, S.: Mechatronics and the Design of Intelligent Machines and Systems. Stanley Thornes, 2000

[2] Schäfer, W.; Wehrheim, H. The Challenges of Building Advanced Mechatronic Systems. In FOSE '07: 2007 Future of Software Engineering, pp. 72-84. IEEE Comp Soc 2007

[3] Lee, Edward A.; „Cyber-Physical Systems – Are Computing Foundations Adequate“; NSF Workshop on CPS Research Motivation Techniques and Roadmap; Austin 2006

[4] ACATECH (National Academy of Science and Engineering), BMBF (Bundesministerium für Bildung und Forschung); „Integrierte Forschungsagenda Cyber-Physical Systems“, Projektflyer BMBF; 2011

[5] US Gouvernement (NSF); „Cyberinfrastructure Vision for 21st Century Discovery”; National Science Foundation Draft; 2006; ISBN: 978-1234500092; 2011

[6] Bundesministerium für Bildung und Forschung; “Forschung und Innovation für Deutschland – Bilanz und Perspektive”; Bonn/ Berlin 2009; p. 17

[7] Kaplan, Robert S.; Norton, David P.: The Balanced Scorecard - Measures that Drive Performance. In: Harvard Business Review; January - February 1992; p. 71 – 79, 1992